longitudinalis piscis 16 uncias, perpendicularis $5\frac{1}{2}$, transversalis $1\frac{3}{4}$. Radii :—Br. 6; D. 12|10; A. 3|9; C. 17; P. 14; V. 1|5."—*Pisces Austr.*, p. 26.

Parkinson's sketch represents the ground colour of the body as aurora-red, with an oblong vertical spot of a deeper tint on each scale. The *Sciæna aurata* of G. Forster, pl. 208, taken in Queen Charlotte's Sound on the 18th of October 1774, may be the same species, though the fin-rays do not exactly correspond, being, as near as they can be made out from the figure, D. 12|12, A. 3|6; nor are the scales of the opercular pieces shown. Forster ascertained the native name of this fish to be "ghooparee."

[To be continued.]

XLIII.—*Some Remarks on the Structure of Dotted Vessels*.* By Professor Hugo Mohl. *Translated from* 'Linnæa,' vol. xvi. p. 1, 1842, *by the* Rev. M. J. Berkeley, M.A., F.L.S.

[With two Plates.]

Notwithstanding the numerous observations which have been published on the structure of dotted vessels, the more recent treatises on the anatomy of plants show that no generally received notions prevail at present on the subject. It may not therefore be superfluous if in the following pages I submit to a more complete investigation some points in their structure to which my attention was turned last year when preparing a dissertation on the subject.

That the difference between my views and those of other phytotomists may be more easily seen, I shall briefly bring together the notions which have been more recently expressed on the subject.

Although many of the earlier observers, especially Leeuwenhoek, Hill, Van Marum, and Hedwig, were acquainted with the dotted vessels, they were first expressly distinguished from the spiral and scalary vessels by Mirbel. He considered their dots as elevations which projected on the exterior of the vessels, and were perforated by a real aperture. He was not acquainted with the articulations of these vessels, and he altogether denied the transition of different forms of vessels into one another. As he distinguished the border from the dot, and was acquainted with the uniform membrane extending between the dots, although his observations in many respects were not correct, he nevertheless laid a founda-

* Getüpfelten Gefässe (glandular fibre and in part dotted ducts, 'Lindl. Introd.' 1832.)

tion on which succeeding phytotomists might have built, and which required only a slight modification to be consistent with facts. This however did not take place, but certain German phytotomists put forth a string of notions which were so many retrograde steps in the knowledge of these vessels.

Sprengel, 'Anleit. zur Kenntniss der Gewächse,' 1802, vol. i. p. 103, first laid the foundation for many later erroneous notions, by deriving the dotted vessels, which he moreover confounded with the scalary vessels, from a confluence of the spiral threads. He was acquainted with the articulations, and attributed them to a strong contraction at different intervals.

Another view which has lately met with many advocates originated with Bernhardi, 'Ueber Pflanzengefässe,' p. 35. He had the merit of discovering the outer membrane of spiral vessels, and referred equally the formation of scalary and dotted vessels to spiral vessels, but in a different way from Sprengel. He supposed the dots to be the isolated fragments of a broken spiral thread.

Treviranus, 'Vom inwend. Bau der Gewächse,' p. 55, deserved especial praise, as regards the intimate knowledge of the structure of vessels, for his discovery of the composition of these organs of distinct coats. He considered the vascular tubes (*Gefässschläuche*) as metamorphosed ligneous tissue (*Holzzellen*), 'Beitrag zur Pflanzenphysiologie,' p. 17, and supposed that there were dissepiments corresponding with the transverse bands, though at a later period they became evanescent. As regards the structure of the dots he is uncertain. He is the first who observed that in the wood of sassafras those parts of the vessels which abut on the medullary rays are furnished with dots of a different form. He considers the dots in general as elevations, but the latter form as apertures.

Moldenhauer, 'Beiträge zur Anatomie der Pflanzen,' p. 264, like Sprengel, derived the porous vessels (*porösen Gefässe*) from spiral and annular vessels, between the threads of which transverse threads had been formed. According to his notion, the threads lay on the outer side of the primary wall of the tube. The assertion, that in the vessels of the lime-tree those sides which abut on another vessel present the form of a porous vessel, while those abutting on cells, on the contrary, have the structure of a spiral vessel, has been unjustly called in question by some later phytotomists.

G. R. Treviranus, 'Vermischte Schriften,' vol. i. p. 149, explained the structure of the dots far more correctly than any of his predecessors, when he regarded them as elevations of the walls of the vessels which are hollow on one side, and have in the middle a puncture-like depression (*Vertiefung*) with a raised border.

Meyen, 'Phytotomie,' p. 227, followed Bernhardi in the supposition that the dots are fragments of a broken spiral thread, only he made the matter still worse by considering the thread as the primary and the tube as the secondary formation.

Link, 'Annal. d. Sc. Natur.,' t. xxiii. p. 152, likewise derived the dots of the vessels from the fracture of a spiral thread. He considered the spiral thread itself as hollow. According to his views, porous vessels are not peculiar organs, the dots themselves being portions of spirals which are shorter than in the scalary vessels; in other cases they are swollen portions of the hollow spiral thread.

In certain treatises which appeared in 1831, ('Ueber den Bau der porösen Gefässe, in den Abhandl. der Acad. zu München,' vol. i. p. 445; 'Ueber den Bau der grossen getüpfelten Röhren von *Ephedra*, in der Linnæa 1831;' 'De Palmarum Structurâ,' §. 26–29), I endeavoured to prove that the structure of the scalary vessels and dotted tubes is in reality analogous to the structure of the dotted cells. I derived the vessels from membranous closed cells, on whose inner surface at a later period membranes and threads are deposited, and whose dissepiments were either completely absorbed or perforated in a reticulate or scalary fashion. With respect to the dotted vessels, I made it appear that the structure accommodated itself to the condition of the neighbouring elementary organs; that the dots were thinner portions of the wall of the vessel, and the border depended on a cavity situated on the outside of the wall of the vessel.

Latterly Link, 'Element. Phil. Bot.,' ed. sec., vol. i. pp. 117, 181, distinguished two forms of vessels under the names of porous and dotted vessels, but the difference assigned is not clear to me. The porous vessels he derived from spiral vessels, whose hollow thread at certain points contracted and then became evanescent, so that the individual fragments of the thread lost their connexion with one another. The dotted vessels are beset with dots, which are relics of spiral vessels, which however become invisible.

The two latest treatises on the dotted vessels of Meyen, 'Neues System der Physiologie,' vol. i. p. 117, and Schleiden, 'Flora,' 1839, vol. i. p. 327, nearly agree with each other. Both derive the dots from fissures which the threads of the secondary coat of the tubes leave open at certain places, in which they are not confluent with each other. Both follow my view of the nature of the border. Schleiden makes the cavity which gives rise to the border contain air, and supposes the fissure which runs above it to be at length rounded off by the further deposition of formative matter. A dependence of the formation of the walls of the vessel on the condition of the neighbouring elementary organs is altogether denied by Meyen.

After this exposition of the more important results of the more recent investigation of the anatomy of dotted vessels, I turn to my own later inquiries, and the first point which demands notice is the fact, that in the dotted vessels of most plants the individual tubes do not possess a uniform structure all round, but that their walls, according as they are in contact with different elementary organs, exhibit not unimportant modifications of structure. That such a relation between the dotted tubes and the neighbouring elementary organs does exist, is indicated by the two isolated cases cited above, observed by Treviranus and Moldenhauer; I have lately endeavoured to show that this appearance is more generally exhibited. I have shown that the structure observed by Moldenhauer in the lime is found in other plants, as in the maple (*Feld-ahorn*), and that the medullary rays in many plants exercise a powerful influence on the structure of the walls of the dotted tubes, as in those parts of the vessel which are in contact with the medullary rays, the dots have an irregular form, are surrounded by no border, are always situated in those places only to which a neighbouring cell is closely pressed, but never where the lateral walls of a neighbouring cell stand perpendicular to them; that moreover the dots of two vessels applied immediately the one to the other exactly correspond. These circumstances, as also the frequently and easily observed phænomenon, that the dots of contiguous cells answer to one another in respect of situation and form, incontestably prove that the organization of the secondary coats of the elementary organs of vegetables stands in close connexion with that of the secondary coats of contiguous elementary organs.

The truth of this position has been much contested, and Meyen especially, 'Physiol.,' vol. i. p. 157, denied that a proof of it could be derived from the structure of the dotted tubes, for he believed the appearances observed by me were analogous to the circumstance, that in the greater part of *Coniferæ* the lateral walls only of their tubes are studded with dots, but not those turned towards the bark and pith. A surprising argument surely, for the dotted tubes of *Coniferæ* show with the greatest certainty the influence which the contact of different organs has upon the organization of a third; so that, in these tubes, those portions only of the lateral walls which abut on other tubes are furnished with large dots surrounded by a border, while in the portions abutting on the medullary rays in most species of *Pinus, Juniperus*, &c., are many small dots destitute of a border, which agree altogether with those which appear on the cells of the medullary rays themselves. Not only the dependence of their formation upon the contiguous organs appears from these tubes, but also more especially from the circumstance that the organization peculiar to the dotted tubes takes place only in such parts as are not subjected to that extraneous influence proceeding from cells.

It will scarcely be objected successfully to the above position, that the influence of contiguous cells cannot be proved in the dotted tubes of all plants, since in a portion of them the dotted tubes exhibit uniform dots in every part, whether in contact with cells or vessels. This clearly proves only thus much, that the influence which neighbouring cells exercise on the formation of vessels is not so important under all circumstances as to prevent the formation of that species of dots peculiar to porous tubes, but that in some plants the power of organization peculiar to the vessels is so exceedingly strong, that, notwithstanding the influence of the neighbouring cells, the peculiar structure of the dotted tubes is effected more or less completely. But from such exceptions an inference can by no means be deduced that this influence does not exist at all *.

* If we consider generally the dependence of the organization of the secondary coats of one elementary organ on that of neighbouring elementary organs, it appears that in this respect there are many degrees of intensity, and that the circumstance is of especial importance, whether the secondary coats of an organ exhibit or not a more or less evident spiral structure. When, for instance, in an elementary organ, whether it be a cell or vascular tube, the secondary coats exhibit a very decided and regular spiral structure, we can find no trace of any influence of the neighbouring organs on the formation of these spiral secondary coats. We observe, then, dextral and sinistral, closely and distantly wound spiral vessels, containing one or more threads, lying near each other; and in like manner, spiral cells similarly circumstanced when their threads are well-developed. In either case the independence of the neighbouring organs appears not only from their threads running in different directions, but especially from the circumstance that the intervals between the threads run uninterruptedly over the angles of their own elementary organ, and over the places where the walls of neighbouring organs stand perpendicular to the outer surface of the former. If, on the contrary, the spiral structure is less decided, and the secondary coats do not any longer assume the form of isolated threads, but exhibit only a spiral streak, there commences immediately a dependence of one elementary organ on its neighbour. If under such circumstances dots are formed, they correspond exactly in their position, but only imperfectly in form, since in either elementary organ lying on the other they may be elongated in the direction

The firmer establishment of what has been asserted will be found in the facts which I shall now detail.

If we examine the organization of dotted vessels with reference to their circumference, we find that in a proportionally small number only of Dicotyledons they possess a structure independent of the surrounding organs. Hence such vessels only come naturally under observation in which, on accurate inquiry, one is really convinced that they do stand in contact with elementary organs of a different nature, and therefore all vessels must be excluded which are surrounded only by prosenchymatous or parenchymatous cells, since these always have on every side uniform walls. If we observe vessels running along unconnected with such cells, as *e.g.* is normally the case in *Rhamnus capensis, Viburnum Opulus*, we find a series of modifications of vascular structure in which the influence of the contiguous organs is in general exhibited with great distinctness.

A. The peculiar structure of the dotted vessels is most perfectly developed in those plants in which the walls of the vessels exhibit no variations, whether standing in contact with other vessels or with cells, in which they are therefore studded uniformly with dots which are surrounded by a border, as in *Elæagnus acuminata, Clematis Vitalba, Broussonetia papyrifera.*

B. To these vessels succeeds a second form, in which those sides of the vessels which stand in contact with prosenchymatous cells are in like manner furnished with equal dots surrounded by a border, but in which the influence exercised by the neighbouring cells is declared by the fact that the dots on the walls which abut on the cells are placed at greater distances. Such vessels occur in *Bixa Orellana, Acacia lophantha, Sophora Japonica.*

C. With a stronger, more decided dependence of the vessels on the cells, the walls abutting on other vessels remain

of the spiral, and, therefore, if the spirals in both are homodromous[1], they cross one another. The more indistinct the spiral structure of the secondary membrane is, and the more it approaches to a reticulate form, the more visible is the dependence of the secondary coats of one organ on those of another. The dots of both organs now correspond not only in position, but also in form and in the direction of their major axis, as for instance in scalary tubes; therefore they no longer cross with those of the contiguous organ; they no longer run over the angles of their own organ, but are closed in their neighbourhood, and are influenced in length by the size of the lateral facets of the contiguous organ. On this depends the difference which we find between the lateral walls of scalary tubes, according as they abut on a vessel or cell, &c.

[1] Compare Ann. and Mag. Nat. Hist., vol. viii. p. 19, and note.—Ed.

very thickly studded with dots; only those in contact with prosenchymatous cells are set with very remote dots, or even (at least for considerable distances) quite free from them. The portions bordering on the medullary rays have simple dots. Such vessels occur in *Sambucus nigra, Betula alba, Aralia spinosa, Corylus Avellana, Populus alba, Alnus incana, Platanus occidentalis, Pyrus malus, Gymnocladus Canadensis.*

D. With a yet stronger influence of the contiguous cells, which possess more commonly the form of parenchymatous than prosenchymatous cells, those portions of the walls only which abut on other vessels exhibit dots surrounded by a border; those portions, on the contrary, abutting on cells, have frequent and large perfectly borderless dots, altogether resembling those of the parenchymatous cells, *e.g. Cassyta glabella, C. filiformis, Bombax pentandrum* (Pl. VII. fig. 12, 13), *Hernandia ovigera.*

E. We have a mere modification of this structure, though possessing a very peculiar appearance, in the form in which the walls which abut on another vessel are fashioned like scalary vessels (Pl. VIII. fig. 2, from *Chilianthus arboreus*), in consequence of the dots being drawn out into fissures which extend the whole breadth of the vessel, while the walls which are contiguous to cells are studded with large unbordered dots (Pl. VIII. fig. 1.). This form is beautifully developed in *Chilianthus arboreus* and *Cynanchum obtusifolium.* In a less degree the same phænomena are exhibited by *Vitis vinifera* in the walls contiguous to vessels.

The greater number of dotted vessels can be referred to one of the heads just enumerated. We have however now to examine in addition a series of vascular forms which agree in the intervals between the rows of dots not being smooth, but marked on the interior wall with a spiral line.

These vessels are to the ordinary dotted vessels what the dotted tubes of *Taxus* are to the other *Coniferæ.* In these vessels not only similar variations occur, as regards the distribution of the dots, as in the lately enumerated vascular forms, but other differences occur, according as a part or all the vessels possess these spiral threads. In some of these plants we may, for instance, though not very nicely, distinguish greater and less vessels of a not always similar structure; their vessels form groups, especially in the inner part of the annular rings, and near these groups, which consist of large vessels, lie others of a far less calibre, whose tubes approach more to the form of prosenchymatous cells, and which I shall indicate in what follows by the name of little vessels.

These vessels may be arranged under the following heads:

F. Collective vessels covered with bordered dots: the larger have smooth walls; in the less, spiral threads run between the rows, *Morus alba, Ulmus campestris, Clematis Vitalba.*

G. Collective vessels closely dotted: between the rows of dots lie small threads, *Hakea oleifolia.*

H. The larger vessels dotted, the less without dots; the walls of both furnished within with spiral threads. *Daphne Mezereum* (Pl. VIII. fig. 7, 8), *Passerina filiformis, Bupleurum arborescens, Genista canariensis.*

I. Walls of vessels which abut on other vessels dotted; those contiguous to cells with distant dots or entirely free from them; walls of either kind of vessels furnished with threads. *Samara pentandra, Tilia parvifolia* (Pl. VIII. fig. 6), *Æsculus Hippocastanum, Acer Pseudo-platanus, Cornus alba, Ilex Aquifolium, Cratægus oxyacantha, Prunus Padus, P. virginiana.*

If we take a glance at what has been said, it is clear from the facts alleged, that the uniformity of the structure of dotted vessels, asserted by phytotomists, exists only in comparatively rare cases; moreover, that the single point in which dotted vessels agree (and even here we must pass unnoticed the smaller vessels mentioned under H.), and by which they are distinguished from other vascular forms, is the presence of dots surrounded by a border, and which lie at least on those sides which are in contact with other vessels.

Under these circumstances then the question arises whether all the alleged vascular forms are to be regarded as dotted vessels, or those vessels only which on all sides exhibit bordered dots, reckoning the rest as mixed vessels, or whether new divisions of vessels are to be grounded on these differences.

In my opinion the first is the proper course. All these vessels possess a common character in the structure of their bordered dots, by which they are easily and surely distinguished from other vessels; and on the other hand, considering them collectively, the presence of dots coincides with the peculiar condition of the embryo of Dicotyledons. If, on the contrary, we regard as mixed vessels all those whose walls exhibit an abnormal structure, our notions, so far from gaining, would only lose in precision. Under the name of mixed vessels, those vessels are usually understood whose different tubes, placed in a line one above the other, exhibit a different structure; *e.g.* they pass from the scalary form into that of annular or spiral vessels. So far as a distinct rule exists in this alternation of vascular forms in many plants, especially in Monocotyledons, the proposal of mixed vessels as an express division is fair enough. But if we would regard as mixed vessels those in which the different sides exhibit a different structure, we confound two things which possess nothing in common, as in the former case the structure of the vessels depends on the course of the vascular bundle, in the latter on the structure of the contiguous elementary organs.

In my opinion nothing could be worse than to have recourse to different names for every slight modification of the dotted vessels. Some modern phytotomists have, alas! taken this path with respect to cellular tissue, a path which would soon lead to the same lamentable labyrinth of terminology in the anatomy of plants as perplexes us in systematic botany.

Most phytotomists make the difference between dotted and scalary vessels to consist in the presence of many small dots. But magnitude and number are far too relative notions upon which to ground an accurate division; we must therefore search for some better distinctive marks. Kieser believed the transverse bands (*Querbänder*) to be characteristic of the dotted vessels as well as the dots; but that such is not the case, inasmuch as these bands are merely the limits of the successive tubes, and also occur in other vascular forms, is clear from the satisfactory inquiries of Moldenhauer and others.

Since these characters also are of no value, we must look for the distinctive sign of the dotted vessels in the structure of the dots themselves, and especially in the circumstance that either all the dots, or at least those which lie on the walls abutting on another vessel, are surrounded by a border.

I should esteem it superfluous, after what I have brought forward in my earlier labours on the structure of bordered dots, to recur to this point if some interest did not appear to be attached to an enumeration of the modifications which are found in the dots of different plants.

Of all the plants I have examined, none appears so fit for acquiring a knowledge of the structure of these organs as *Cassyta glabella*, on account of the remarkable size of its dots (Pl. VII. fig. 1). In this plant, if we take delicate transverse or longitudinal slices (Pl. VII. fig. 2), we can with the greatest certainty be convinced that the border of the dots depends on a cavity (*a*) which lies between the contiguous walls, and that the dot itself (*b*) is a canal running from the inside of the vessel to this hollow, and at its outer extremity closed with a delicate membrane. It is rather more difficult to recognise the structure in other plants, yet in those whose dots are not too small, as in *Laurus nobilis* (Pl. VII. fig. 9), *L. Sassafras*, *Aleurites triloba*, *Acacia lophantha*, it is quite possible with the help of a good microscope to do so.

If we examine the walls of dotted vessels in a direction perpendicular to their surface, we find in almost all plants that both the punctures themselves and the border are extended in length, in a direction transverse to the vessel. In consequence the little cavity towards which the canal of the dots leads, and which produces the border, has an elliptic outline. The canal, on the contrary, does not form an elliptic tube of uniform width, but has a form somewhat more complicated. It is compressed in the direction of the axis of the vessel, but at the same time widened in the direction of its diameter. The inner aperture, therefore, of the canal presents a shorter or longer fissure; the outer, closed by the primitive membrane, presents an ellipse more or less approaching to a circle. If we examine the vessel on its inner surface, and look perpendicularly into a canal, we see the lateral portions of its walls running down obliquely towards each other in the shape of two gutter-like surfaces (Pl. VII. fig. 4, *Cassyta glabella*); while its upper and lower walls are invisible, being perpendicular to the eye of the observer. From this form of the canals it is clear why they appear under a different aspect according as a section is made vertically or transversely; in the former case (Pl. VII. fig. 9, *Laurus nobilis*) they exhibit a conical, in the latter (Pl. VII. fig. 2, *Cassyta glabella*) a cylindrical outline. Moreover a transverse section exhibits a very different form, according as it is made near the outer or inner aperture. In the former case it has a broad elliptic form; in the latter it has more resemblance to a linear fissure. This is clearly visible if a longitudinal section be made in an oblique direction through the wall of a vessel.

The extension in width which the canals of the dots exhibit within, is in a portion of Dicotyledons not very remarkable, so that the inner aperture is shorter than the border of the dot; *e.g.* in *Cassyta glabella* (Pl. VII. fig. 1, 4), *Bombax pentandrum* (Pl. VII. fig. 12), *Bixa Orellana, Acacia lophantha, Sophora japonica, Salix alba, Aralia spinosa*; in other plants, on the contrary, the inner aperture presents a fissure which is longer than the border, *e. g.* in *Laurus Sassafras* (Pl. VII. fig. 5), *Aleurites triloba* (Pl. VII. fig. 6, 8), *Clematis Vitalba* (Pl. VIII. fig. 4), *Cornus alba, Morus alba, Gymnocladus canadensis, Elæagnus acuminata* (Pl. VII. fig. 10, 11). In this case it very frequently happens, and in many vessels with a certain degree of regularity, that the fissures of neighbouring dots run together, so that the inner wall of the vessel is pierced with transverse or obliquely situated grooves, into which from two to six and often more canals open. Exactly the same structure as in the elliptic dots is found in the transverse fissures which in *Chilianthus arboreus* clothe the walls of the vessels which abut on other vessels (Pl. VIII. fig. 2), and give them the appearance of scalary tubes. Each of these fissures is surrounded by a border which depends upon the existence of a linear cavity running beneath the fissure, which is much wider than it, as is plainly observable in vertical sections of contiguous vessels (Pl. VIII. fig. 3). They are distinguished at first sight from ordinary scalary tubes, though so similar in other respects, by the presence of this cavity, of which no trace exists in scalary vessels, as we may convince ourselves in tree-ferns and large Monocotyledons.

Besides these bordered dots which distinguish dotted from other vessels, as we have seen above, there is, in a great number of plants, yet another modification of dots which are surrounded by no border. These are most frequently found in those situations which lie near to medullary rays; there are however also vessels in which all the walls not in contact with another vessel exhibit this form of dots, *e. g. Cassyta, Bombax pentandrum* (Pl. VII. fig. 13), *Hernandia ovigera, Chilianthus arboreus* (Pl. VIII. fig. 1). These dots have generally a far less remarkable size than those which are bordered, and generally a transversely oval form. On a more accurate examination they are found to be surrounded by a double line, so that in many cases (especially in *Aleurites triloba* (Pl. VII. fig. 7)) one might almost be forced to ascribe to them also a small border. A more perfect inspection, especially of an oblique section of the walls of these vessels, shows, on the contrary, that between these dots and the neighbouring organs no cavity exists, but that they are formed by a simple perforation of the secondary coat, and therefore accord perfectly with the dots of parenchymatous cells, reticulate vessels and scalary tubes. The double line surrounding the orifice of the dots arises from their being generally somewhat wider towards the inside of the vessel; and therefore, if we examine them in a direction perpendicular to the wall of the vessel, both the inner orifice of the canal of the dot in the inside of the vessel, and the outer closed by the primary coat, are at once visible. If, as is not rarely the case, the canal perforates the wall of the vessel in a somewhat oblique direction, if we look down perpendicularly upon the walls, both these lines coincide on the one side of the dot, or cross each other (Pl. VIII. fig. 5 *a a, Cactus brasiliensis*).

It is clear, that the dotted vessels, by means of this last kind of dots, form the transition to scalary and reticulate vessels, as they exist in vascular Cryptogams and Monocotyledons, for the walls possessing these dots agree perfectly with the walls of scalary vessels which abut on parenchymatous cells. The relation of these two forms of vessels is also indicated by the fact, that in particular Dicotyledons the dotted vessels are altogether replaced by reticulate vessels (Pl. VIII. fig. 5, *Cactus brasiliensis*). As regards the transverse dissepiments of dotted vessels, I confine myself to a few remarks, as I have before proved that the dissepiments of vascular tubes are not always, though the case is generally otherwise, absorbed in the course of the formation of vessels, but sometimes remain, though in that case pierced with real perforations. In the dotted vessels these dissepiments appear chiefly under two forms: either the original dissepiment in great part remains, and a round aperture is formed in its centre, whose diameter is about one-half or one-third of that of the dissepiment; *e. g. Cassyta glabella* (Pl. VII. fig. 3), *Ficus martinicensis, Cactus brasiliensis* (Pl. VIII. fig. 5); or they are perforated with many transverse fissures seated one above the other so as to resemble the walls of a scalary vessel.

This last form I find only in the obliquely lying dissepiments; they exist, *e. g.* in *Betula alba, Fagus sylvatica, Corylus Avellana, Alnus incana, Platanus occidentalis, Viburnum Opulus, Ilex Aquifolium*; while the first form is more frequent in those which are horizontal. The dissepiments of the same plant do not however always exhibit the same structure, but some may possess the form of a scalary wall, while others are completely absorbed. Oblique dissepiments have such a direction that their surface comes into view on a longitudinal section parallel to the medullary rays.

I shall add merely a few words on the history of the development of dotted vessels. They appear in the early period of their evolution, like the other vessels, as rows of large, cell-like, perfectly closed tubes whose skin is thin and perfectly uniform, of which every one possesses a nucleus (*Zellenkern*). At a later period we see in the lateral walls, especially those resting on other vessels, as it were a delicate fibrous net-work. A further inspection of the development shows that this does not (as one might at the first glance have been induced to believe) depend on threads deposited on the inner walls of the vessel, but that the meshes of the net correspond with the future borders of the dots, and therefore indicate the cavities which lie between the vessels; that the apparent threads which surround the meshes are formed by the places of the walls of the vessel which remain in contact with the neighbouring organ; and that at this time, as well as during the whole process of development, the vascular tubes are filled with sap, and not with air as Schleiden asserted. Shortly after the appearance of these cavities the first trace of the dot over each of them is indicated by a lighter circle, and now, by means of the further thickening of the walls the formation of the vessel speedily arrives at its extreme limit, at which time also the transverse dissepiments are absorbed. I have not observed in these vessels more than in the secondary membranes of cells, any origination of secondary coats from the inosculation of spiral threads.

It should seem from what has been adduced above as to the form of the canals of the dots,—whence it clearly appears that the apertures of the secondary coat are so much larger, and in particular so much the more drawn out in the direction of their major axis into the form of fissures, the nearer they lie to the centre of the tube,—that the different secondary coats of the same vascular tube do not accurately agree in their form. In some plants, as in *Bombax pentandrum* (Pl. VII. fig. 12, 14.), this circumstance is indicated merely by a slight conical enlargement of the canal from the outer to the inner side. It is far more remarkable in the form which I have represented from *Cassyta glabella* (Pl. VII. fig. 1, 4). The difference between the outer and the inner secondary coats attains a far more noticeable degree in *Laurus Sassafras* (Pl. VII. fig. 5), *Aleurites triloba* (Pl. VII. fig. 6, 8), *Elæagnus acuminata* (Pl. VII. fig. 10, 11), *Clematis Vitalba* (Pl. VIII. fig. 4). Here the cavities of the outer secondary coat present a dot which is shorter than the border, while, on the contrary, those of the inner coats (Pl. VIII. fig. 4, 6) are extended into such long fissures, that they are not merely longer than the subjacent border, but frequently run one into another and comprise the canals of many dots. These inner layers, therefore, represent skins, which are imperfectly divided into broad threads by long and short fissures. It is to be remarked here, that the direction of the fissures of the inner layers does not always perfectly agree with the direction of the major axis of the canals of the dots, but intersects it at a small angle (Pl. VII. fig. 6). This will be the less surprising if we remember that the threads in *Taxus* which form the innermost layer of the vessels run sometimes in an opposite direction to the spiral line in which the major axes of the dots lie; and that the bast-cells of *Apocyneæ* are composed of coats whose spiral striæ exhibit equally a different direction of volution. We find the greatest degree of difference between the outer and inner coats of the vessels in *Tilia* (Pl. VIII. fig. 6), *Daphne* (Pl. VIII. fig. 7), and other plants adduced above under F— I, in which a perfect division of the inner membrane of the vessel into spiral threads exists; a formation which clearly exhibits merely a still further development of the forms hitherto considered.

EXPLANATION OF THE PLATES.

The fractions under the figures show the degree in which they are magnified.

Plate VII.

Fig. 1. *Cassyta glabella.* The lateral wall of a dotted tube abutting on another vessel.

Fig. 2. *Cassyta glabella.* Vertical section through the walls of two dotted vessels applied to one another. *a.* Cavity between two dots; *b.* canal of dot.

Fig. 3. *Cassyta glabella.* The transverse dissepiment of a dotted vessel pierced by a round aperture.

Fig. 4. Dot more highly magnified.

Fig. 5. *Laurus Sassafras.* Portion of a dotted vessel. The canals of the dots are widened on the inner side in the form of long fissures.

Fig. 6. *Aleurites triloba.* Wall of a dotted vessel which is contiguous to another vessel.

Fig. 7. *Aleurites triloba.* Wall of a dotted vessel which is contiguous to a cell. The canals of the dots are so strongly widened within, that the dots appear to be surrounded by a border.

Fig. 8. *Aleurites triloba.* A dot from fig. 6. more highly magnified.

Fig. 9. *Laurus nobilis.* Transverse section through the walls of two contiguous dotted vessels. Funnel-shaped widening of the canals of the dots toward the inner surface of the vessel.

Fig. 10. *Elæagnus acuminata.* Portion of a dotted vessel; fissure-like form of the canals of the dots.

Fig. 11. A dot of the same more highly magnified.

Fig. 12. *Bombax pentandrum.* Wall of a dotted vessel which borders on a second vessel.

Fig. 13. *Bombax pentandrum.* Wall of a dotted vessel contiguous to a cell. The canal of the dots is widened within.

Plate VIII.

Fig. 1. *Chilianthus arboreus.* Wall of a dotted tube contiguous to a cell.

Fig. 2. *Chilianthus arboreus.* Wall of a dotted tube contiguous to another vessel. The dots are very much widened, so as to make the vessel appear like a scalary tube.

Fig. 3. *Chilianthus arboreus.* Vertical section through the walls of two contiguous vessels.

Fig. 4. *Clematis Vitalba.* Dotted vessel. *a.* Portion of the same uninjured; *b.* portion with the outer coat of the walls of the vessel removed by an oblique section, so that the fissure-like form of the inner aperture of the canals of the dots may be more clearly seen.

Fig. 5. Reticulate vessel of *Cactus brasiliensis.* The canals of the dots at *a* have an oblique direction, in consequence of which the lines which indicate the outer and inner aperture cross one another.

Fig. 6. *Tilia parvifolia.* Wall of a dotted tube contiguous to a second vessel.

Fig. 7. *Daphne Mezereum.* Large dotted tube.

Fig. 8. *Daphne Mezereum.* Small dotted tube, which is merely marked by threads without any dots.